# Guidelines and Standard Operating Procedure (SOP) for the Handling, Use, and Storage of Compressed Gas Cylinders

There are multiple hazards associated with compressed gas cylinders, which can roughly be grouped in two categories:

**1) Mechanical hazards**

$ Compressed gas cylinders are sleeping giants - a full standard size cylinder at a pressure of ~ 200 atm contains the kinetic energy equivalent to a small anti-tank weapon. Cylinders whose valves were accidentally broken off have been known to fly in excess of 500 m and penetrate reinforced concrete walls. **Breaking off a valve from a full cylinder is the ultimate accident and all operations should aim at absolutely avoiding this incident.**

$ Compressed gas cylinders are heavy - especially when full ! In a recent incident at a university in Ontario a student severly injured several fingers when an improperly handled cylinder crushed his hand.

$ Compressed gas cylinders typically come with brass valves, i.e. threaded connections made from a relatively soft metal designed to give gas-tight metal-metal seals that can easily be damaged with potentially disastrous consequences when improperly installed.

**2) Hazards from the cylinders content**

Depending on the type of gas contained in the cylinder several hazards or (multiple) combinations thereof can exist. These are in particular:

$ Asphyxiation: All gases available in compressed gas cylinders (except breathable air) will lead to death by asphyxiation, if their concentration within any enclosed space, such as laboratory exceeds certain levels. A particular hazard may arise from Asimulated air@, i.e. cylinders that contain a 80:20 mixture of $N_2$ and $O_2$ but no $CO_2$. As breathing is controlled by the $CO_2$ concentration in the blood one can thus asphyxiate, even though Aair@ is present.

$ Ignition and/or explosion hazards from flammable gases: Many gases in particular $H_2$, but also a variety of organic compounds such as ethylene, propene, or methane are flammable and can turn a cylinder into a flame-thrower if ignited. Even a very small leak

on an improperly installed gas-valve or otherwise compromised cylinder can lead to build-up of flammable or, worse, explosive gas/air mixtures within enclosed spaces. A particular hazard are cylinders containing $F_2$ (e.g. sometimes used in LASER labs), as $F_2$ will spontaneously ignite with any organic matter with which it comes in contact.

$ Poisoning of people and/or environment from toxic and/or corrosive gases: A variety of gases available in compressed gas cylinders are highly toxic, for example CO and $H_2S$. Others are toxic as well as corrosive to tissue (in particular in the respiratory tract and the eyes) and equipment. Examples of the latter class are $Cl_2$, $NO_x$, or $SO_3$.

## In light of these hazards the safety committee mandates the following Standard Operating Procedures for the handling, use, and storage of compressed gas cylinders in the Department of Chemistry & Biochemistry at the University of Guelph:

1) Any gas cylinder that is being moved - however short the distance - **must** have a safety cap screwed over the valve on top of the cylinder. **This rule is of the utmost importance and applies irrespective of the content (Aharmless@, toxic, flammable, corrosive) and status (full, empty) of the cylinder.**

**Never, ever move a cylinder without the safety cap on !**

2) If a cylinder is to be moved more than 2 m, this **must** be done using a cart specifically designed for this purpose and fitted with a securing chain. Such carts are available from the small room between the elevator and the loading dock on the ground floor of the C&M Building.

3) All cylinders must be stored in an upright position and secured to a table, lab bench, or wall using an appropriate strap or chain holder as purchased from a laboratory equipment supplier or custom made by the machine shop.

4) The amount of gas cylinders stored in any laboratory should be kept to the absolute minimum. Any gas cylinders received on the loading dock should be moved into the laboratory which ordered it the same day it is delivered. Empty gas cylinders should be returned promptly and not unnecessarily be stored in the laboratories.

5) Never use excessive force when fitting a pressure-reducing diaphragm regulator to a cylinder. The correct procedure for installing a valve is as follows:

a) Choose the right regulator with the correct pressure output range for the intended application. Never use adapters for attaching regulators.

b) Make sure the threads on both the regulator and the cylinder valve are clean and in good condition.

c) The use of TeflonJ tape on the threaded connection is not recommended and unnecessary if the regulator and tank threads are in good condition.

d) Holding the regulator vertically and horizontally at a right angle to the cylinder head connect it to the cylinder valve by closing the thread finger-tight. The thread should move very easily, if it does not it is either damaged or you are not holding it at right angle, i.e. are damaging it as you try to force it in. Using a wrench tighten the connection with a maximum of one turn. Never use excessive force to tighten the connection.

e) **Leak check** your connection using either commercially available ASnoop@ or a mixture of water/isopropanol/dish soap (100:100:1).

6) With the exception of $N_2$, Ar, He, and air (specifically excluding Asimulated air@ !) all gases originating from a compressed gas cylinder must ultimately be vented into a fume-hood. Due to the small gas volumes involved this stipulation is waived for FID, TCD, etc. detectors on GCs.

7) Toxic, flammable, and corrosive gases must be stored outside the building. The MacNaughton building loading dock has a gas cylinder storage area for this purpose. Only such gases "in service" may be kept in the laboratory.

8) It is the individual researchers'/supervisors' responsibility that any used or stored gas cylinders as well as feed lines originating from them are kept in good conditions and tested for leakage on a regular basis.

Additional recommendations:

- If CO(g) is to be used on a regular basis in any given laboratory (e.g. for hydroformylation studies) an electronic CO(g) sensor should be permanently installed and regularly tested. A written record of these tests should to be kept.
- The location and type of individual cylinders in the laboratory should be indicated on a floor-plan posted to the outside of the laboratory entrance door.
- Corrosive gases should not be kept longer than 3 months. Return to supplier, even if there is gas remaining in the cylinder.

Further information is available from the University of Guelph Safety Policy Manual.